



THE DATASHEET OF MPY100CG





MPY100

MULTIPLIER-DIVIDER

FEATURES

- LOW COST
- DIFFERENTIAL INPUT
- ACCURACY 100% TESTED AND GUARANTEED
- NO EXTERNAL TRIMMING REQUIRED
- LOW NOISE: 90 μ Vrms, 10Hz to 10kHz
- HIGHLY RELIABLE ONE-CHIP DESIGN
- DIP OR TO-100 TYPE PACKAGE
- WIDE TEMPERATURE OPERATION

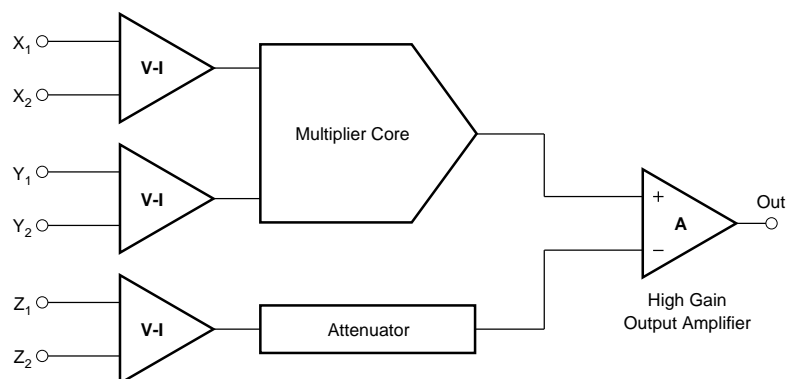
APPLICATIONS

- MULTIPLICATION
- DIVISION
- SQUARING
- SQUARE ROOT
- LINEARIZATION
- POWER COMPUTATION
- ANALOG SIGNAL PROCESSING
- ALGEBRAIC COMPUTATION
- TRUE RMS-TO-DC CONVERSION

DESCRIPTION

The MPY100 multiplier-divider is a low cost precision device designed for general purpose application. In addition to four-quadrant multiplication, it also performs analog square root and division without the bother of external amplifiers or potentiometers. Laser-trimmed one-chip design offers the most in highly

reliable operation with guaranteed accuracies. Because of the internal reference and pretrimmed accuracies the MPY100 does not have the restrictions of other low cost multipliers. It is available in both TO-100 and DIP ceramic packages.



International Airport Industrial Park • Mailing Address: PO Box 11400 • Tucson, AZ 85734 • Street Address: 6730 S. Tucson Blvd. • Tucson, AZ 85706
Tel: (520) 746-1111 • Twx: 910-952-1111 • Cable: BBRCORP • Telex: 066-6491 • FAX: (520) 889-1510 • Immediate Product Info: (800) 548-6132

SPECIFICATIONS

At $T_A = +25^\circ\text{C}$ and $\pm V_S = 15\text{VDC}$, unless otherwise specified.

| PARAMETER | CONDITIONS | MPY100A | | | MPY100B/C | | | MPY100S | | | UNITS |
|---|--|---|-------------|--------------|-----------|-----------------|-------------------|-----------------|-------------|------------|-------------------------|
| | | MIN | TYP | MAX | MIN | TYP | MAX | MIN | TYP | MAX | |
| MULTIPLIER PERFORMANCE | | | | | | | | | | | |
| Transfer Function | | $\frac{(X_1 - X_2)(Y_1 - Y_2)}{10} + Z_2$ | | | | */* | | | * | | |
| Total Error | $-10\text{V} \leq X, Y \leq 10\text{V}$ | | | | | | | | | | |
| Initial | $T_A = +25^\circ\text{C}$ | | | ± 2.0 | | | $\pm 1.0/0.5$ | | | ± 0.5 | % FSR |
| vs Temperature | $-25^\circ\text{C} \leq T_A \leq +85^\circ\text{C}$ | | ± 0.017 | ± 0.05 | | | $\pm 0.008/0.008$ | $\pm 0.02/0.02$ | | | % FSR/ $^\circ\text{C}$ |
| vs Temperature | $-55^\circ\text{C} \leq T_A \leq +125^\circ\text{C}$ | | | | | | | | ± 0.025 | ± 0.05 | % FSR/ $^\circ\text{C}$ |
| vs Supply ⁽¹⁾ | | | ± 0.05 | | | | */* | | * | | % FSR/% |
| Individual Errors | | | | | | | | | | | |
| Output Offset | | | | | | | | | | | |
| Initial | $T_A = +25^\circ\text{C}$ | | ± 50 | ± 100 | | $\pm 10/7$ | $\pm 50/25$ | | ± 7 | ± 50 | mV |
| vs Temperature | $-25^\circ\text{C} \leq T_A \leq +85^\circ\text{C}$ | | ± 0.7 | ± 2.0 | | $\pm 0.7/0.3$ | $\pm 2.0/\pm 0.7$ | | | | mV/ $^\circ\text{C}$ |
| vs Temperature | $-55^\circ\text{C} \leq T_A \leq +125^\circ\text{C}$ | | | | | | | | ± 0.3 | ± 0.7 | mV/ $^\circ\text{C}$ |
| vs Supply ⁽¹⁾ | | | ± 0.25 | | | */* | | | * | | mV/% |
| Scale Factor Error | | | | | | | | | | | |
| Initial | $T_A = +25^\circ\text{C}$ | | ± 0.12 | | | */* | | | * | | % FSR |
| vs Temperature | $-25^\circ\text{C} \leq T_A \leq +85^\circ\text{C}$ | | ± 0.008 | | | */* | | | | | % FSR/ $^\circ\text{C}$ |
| vs Temperature | $-55^\circ\text{C} \leq T_A \leq +125^\circ\text{C}$ | | | | | | | | ± 0.008 | | % FSR/ $^\circ\text{C}$ |
| vs Supply ⁽¹⁾ | | | ± 0.05 | | | */* | | | * | | % FSR % |
| Nonlinearity | | | | | | | | | | | |
| X Input | $X = 20\text{Vp-p}; Y = \pm 10\text{VDC}$ | | ± 0.08 | | | */* | | | * | | % FSR |
| Y Input | $Y = 20\text{Vp-p}; X = \pm 10\text{VDC}$ | | ± 0.08 | | | */* | | | * | | % FSR |
| Feedthrough | | | | | | | | | | | |
| | $f = 50\text{Hz}$ | | | | | | | | | | |
| X Input | $X = 20\text{Vp-p}; Y = 0$ | | 100 | | | 30/30 | | | 30 | | mVp-p |
| Y Input | $Y = 20\text{Vp-p}; X = 0$ | | 6 | | | */* | | | * | | mVp-p |
| vs Temperature | $-25^\circ\text{C} \leq T_A \leq +85^\circ\text{C}$ | | 0.1 | | | */* | | | | | mVp-p/ $^\circ\text{C}$ |
| vs Temperature | $-55^\circ\text{C} \leq T_A \leq 125^\circ\text{C}$ | | | | | | | | 0.1 | | mVp-p/ $^\circ\text{C}$ |
| vs Supply ⁽¹⁾ | | | 0.15 | | | */* | | | * | | mVp-p/% |
| DIVIDER PERFORMANCE | | | | | | | | | | | |
| Transfer Function | $X_1 > X_2$ | $\frac{10(Z_2 - Z_1)}{(X_1 - X_2)} + Y_1$ | | | | */* | | | * | | |
| Total Error (with external adjustments) | $X = 10\text{V}$ $-10\text{V} \leq Z \leq +10\text{V}$ $X = 1\text{V}$ $-1\text{V} \leq Z \leq +1\text{V}$ $+0.2\text{V} \leq X \leq +10\text{V}$ $-10\text{V} \leq Z \leq +10\text{V}$ | | ± 1.5 | | | $\pm 0.75/0.35$ | | | ± 0.35 | | % FSR |
| | | | ± 4.0 | | | $\pm 2.0/1.0$ | | | ± 1.0 | | % FSR |
| | | | ± 5.0 | | | $\pm 2.5/1.0$ | | | ± 1.0 | | % FSR |
| SQUARER PERFORMANCE | | | | | | | | | | | |
| Transfer Function | | $\frac{(X_1 - X_2)^2}{10} + Z_2$ | | | | */* | | | * | | |
| Total Error | $-10\text{V} \leq X \leq +10\text{V}$ | | ± 1.2 | | | $\pm 0.6/0.3$ | | | ± 0.3 | | % FSR |
| SQUARE ROOTER PERFORMANCE | | | | | | | | | | | |
| Transfer Function | $Z_1 < Z_2$ | $+\sqrt{10(Z_2 - Z_1) + X_2}$ | | | | */* | | | * | | |
| Total Error | $1\text{V} \leq Z \leq 10\text{V}$ | | ± 2 | | | $\pm 1/0.5$ | | | ± 0.5 | | % FSR |
| AC PERFORMANCE | | | | | | | | | | | |
| Small-Signal Bandwidth | | | 550 | | | */* | | | * | | kHz |
| % Amplitude Error | Small-Signal | | 70 | | | */* | | | * | | kHz |
| (0.57°) Vector Error | Small-Signal | | 5 | | | */* | | | * | | kHz |
| Full Power Bandwidth | $ V_O = 10\text{V}, R_L = 2\text{k}\Omega$ | | 320 | | | */* | | | * | | kHz |
| Slew Rate | $ V_O = 10\text{V}, R_L = 2\text{k}\Omega$ | | 20 | | | */* | | | * | | V/ μs |
| Settling Time | $\epsilon = \pm 1\%, \Delta V_O = 20\text{V}$ | | 2 | | | */* | | | * | | μs |
| Overload Recovery | 50% Output Overload | | 0.2 | | | */* | | | * | | μs |
| INPUT CHARACTERISTICS | | | | | | | | | | | |
| Input Voltage Range | | ± 10 | | | | */* | | | * | | V |
| Rated Operation | | | | $\pm V_{CC}$ | | | | | | * | V |
| Absolute Maximum | | | | | | | | | | * | V |
| Input Resistance | X, Y, Z ⁽²⁾ | | 10 | | | */* | | | * | | M Ω |
| Input Bias Current | X, Y, Z | | 1.4 | | | */* | | | * | | μA |
| OUTPUT CHARACTERISTICS | | | | | | | | | | | |
| Rated Output | | | | | | | | | | | |
| Voltage | $I_O = \pm 5\text{mA}$ | ± 10 | | | | */* | | | * | | V |
| Current | $V_O = \pm 10\text{V}$ | ± 5 | | | | */* | | | * | | mA |
| Output Resistance | $f = \text{DC}$ | | 1.5 | | | */* | | | * | | Ω |

SPECIFICATIONS (CONT)

At $T_A = +25^\circ\text{C}$ and $\pm V_S = 15\text{VDC}$, unless otherwise specified.

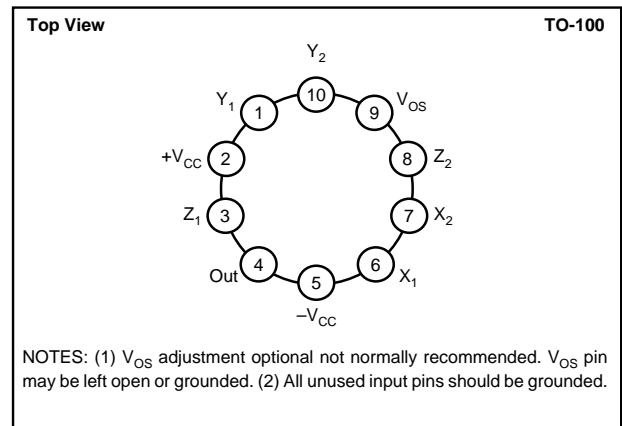
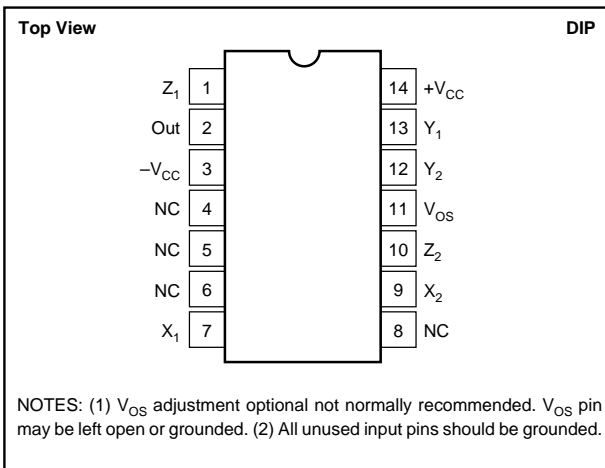
| PARAMETER | CONDITIONS | MPY100A | | | MPY100B/C | | | MPY100S | | | UNITS |
|---|---------------------|-------------------|--------------------------------|---------------------|----------------|----------------------------|----------------|----------|-------------------|----------------|---|
| | | MIN | TYP | MAX | MIN | TYP | MAX | MIN | TYP | MAX | |
| OUTPUT NOISE VOLTAGE $f_O = 1\text{Hz}$ $f_O = 1\text{kHz}$ $1/f$ Corner Frequency $f_B = 5\text{Hz to } 10\text{kHz}$ $f_B = 5\text{Hz to } 5\text{MHz}$ | $X = Y = 0$ | | 6.2 0.6 110 60 1.3 | | | */ */ */ */ */ | | | ** * * * | | $\mu\text{V}/\sqrt{\text{Hz}}$ $\mu\text{V}/\sqrt{\text{Hz}}$ Hz μVrms mVrms |
| POWER SUPPLY REQUIREMENTS Rated Voltage Operating Range Quiescent Current | Derated Performance | ± 8.5 | ± 15 ± 5.5 | ± 20 | */ */ */ | */ */ */ | */ */ */ | ** * | ** * | ** * | VDC VDC mA |
| TEMPERATURE RANGE (Ambient) Specification Operating Range Storage | Derated Performance | -25 -55 -65 | | +85 +125 +150 | */ */ */ | | */ */ */ | -55 * | | +125 * * | $^\circ\text{C}$ $^\circ\text{C}$ $^\circ\text{C}$ |

* Same as MPY100A specification.

*/ B/C grades same as MPY100A specification.

NOTES: (1) Includes effects of recommended null pots. (2) Z_2 input resistance is $10\text{M}\Omega$, typical, with V_{OS} pin open. If V_{OS} pin is grounded or used for optional offset adjustment, the Z_2 input resistance may be as low as $25\text{k}\Omega$

PIN CONFIGURATIONS



ABSOLUTE MAXIMUM RATINGS

| | |
|--|--|
| Supply | $\pm 20\text{VDC}$ |
| Internal Power Dissipation ⁽¹⁾ | 500mW |
| Differential Input Voltage ⁽²⁾ | $\pm 40\text{VDC}$ |
| Input Voltage Range ⁽²⁾ | $\pm 20\text{VDC}$ |
| Storage Temperature Range | $-65^\circ\text{C to } +150^\circ\text{C}$ |
| Operating Temperature Range | $-55^\circ\text{C to } +125^\circ\text{C}$ |
| Lead Temperature (soldering, 10s) | $+300^\circ\text{C}$ |
| Output Short-circuit Duration ⁽³⁾ | Continuous |
| Junction Temperature | $+150^\circ\text{C}$ |

NOTES: (1) Package must be derated on $\theta_{JC} = 15^\circ\text{C/W}$ and $\theta_{JA} = 165^\circ\text{C/W}$ for the metal package and $\theta_{JC} = 35^\circ\text{C/W}$ and $\theta_{JA} = 220^\circ\text{C/W}$ for the ceramic package. (2) For supply voltages less than $\pm 20\text{VDC}$, the absolute maximum input voltage is equal to the supply voltage. (3) Short-circuit may be to ground only. Rating applies to $+85^\circ\text{C}$ ambient for the metal package and $+65^\circ\text{C}$ for the ceramic package.

ORDERING INFORMATION

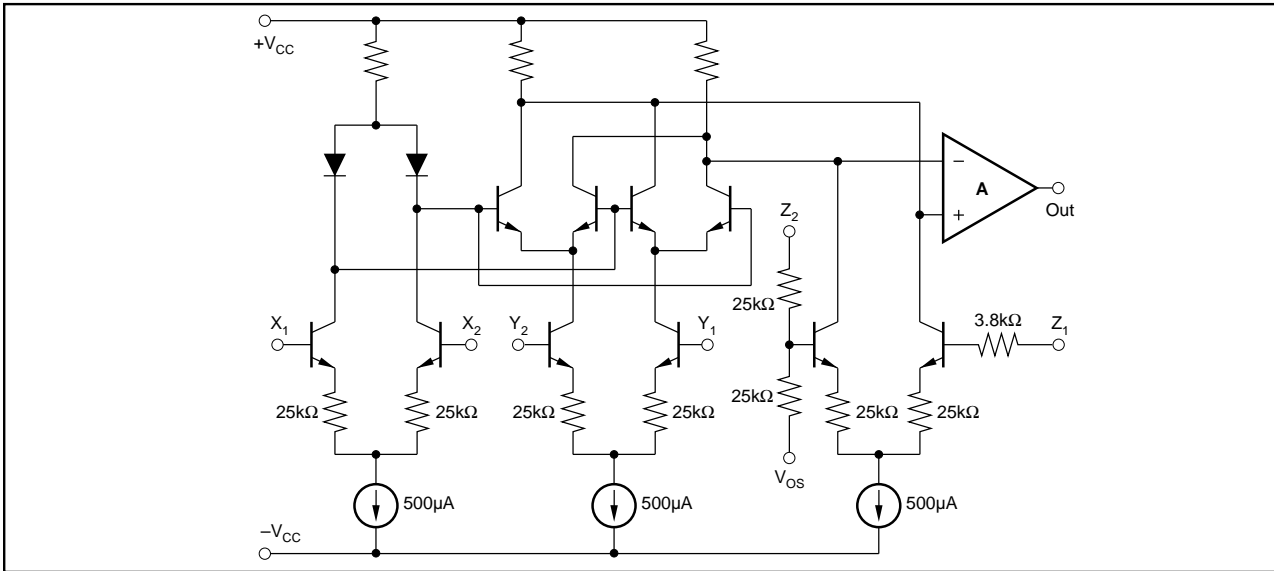
| MODEL | PACKAGE | TEMPERATURE RANGE |
|----------|--------------------|--|
| MPY100AG | 14-Pin Ceramic DIP | $-25^\circ\text{C to } +85^\circ\text{C}$ |
| MPY100AM | Metal TO-100 | $-25^\circ\text{C to } +85^\circ\text{C}$ |
| MPY100BG | 14-Pin Ceramic DIP | $-25^\circ\text{C to } +85^\circ\text{C}$ |
| MPY100BM | Metal TO-100 | $-25^\circ\text{C to } +85^\circ\text{C}$ |
| MPY100CG | 14-Pin Ceramic DIP | $-25^\circ\text{C to } +85^\circ\text{C}$ |
| MPY100CM | Metal TO-100 | $-25^\circ\text{C to } +85^\circ\text{C}$ |
| MPY100SG | 14-Pin Ceramic DIP | $-55^\circ\text{C to } +125^\circ\text{C}$ |
| MPY100SM | Metal TO-100 | $-55^\circ\text{C to } +125^\circ\text{C}$ |

PACKAGE INFORMATION

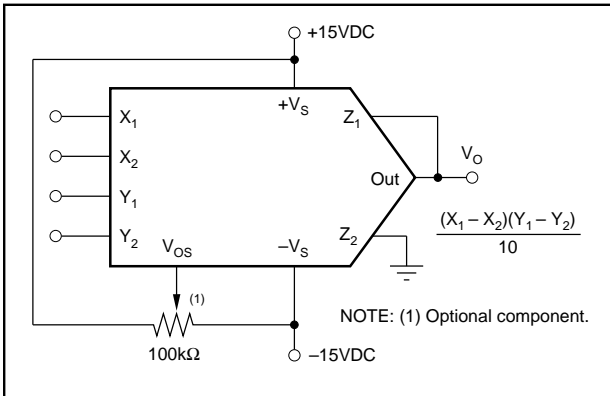
| MODEL | PACKAGE | PACKAGE DRAWING NUMBER ⁽¹⁾ |
|----------|--------------------|---------------------------------------|
| MPY100AG | 14-Pin Ceramic DIP | 169 |
| MPY100AM | Metal TO-100 | 007 |
| MPY100BG | 14-Pin Ceramic DIP | 169 |
| MPY100BM | Metal TO-100 | 007 |
| MPY100CG | 14-Pin Ceramic DIP | 169 |
| MPY100CM | Metal TO-100 | 007 |
| MPY100SG | 14-Pin Ceramic DIP | 169 |
| MPY100SM | Metal TO-100 | 007 |

NOTE: (1) For detailed drawing and dimension table, please see end of data sheet, or Appendix D of Burr-Brown IC Data Book.

SIMPLIFIED SCHEMATIC



CONNECTION DIAGRAM



DICE INFORMATION

| PAD | FUNCTION |
|-----|-----------------|
| 1 | Y ₂ |
| 2 | V _{OS} |
| 3 | Z ₂ |
| 4 | X ₂ |
| 5 | X ₁ |
| 6 | V _O |
| 7 | Z ₁ |
| 8 | +V |
| 9 | -V |
| 10 | Y ₁ |

Substrate Bias: -V_{CC}

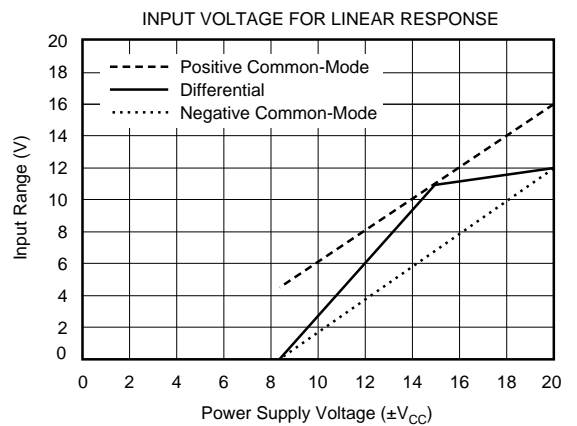
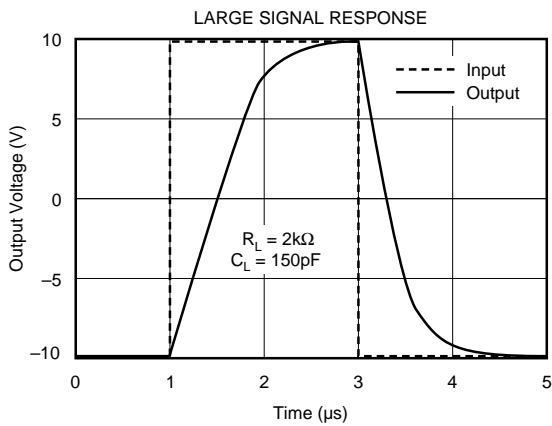
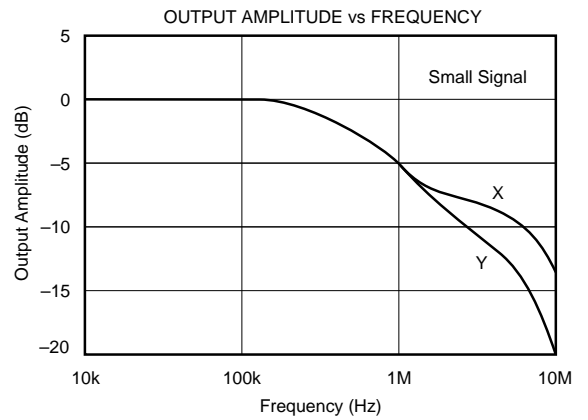
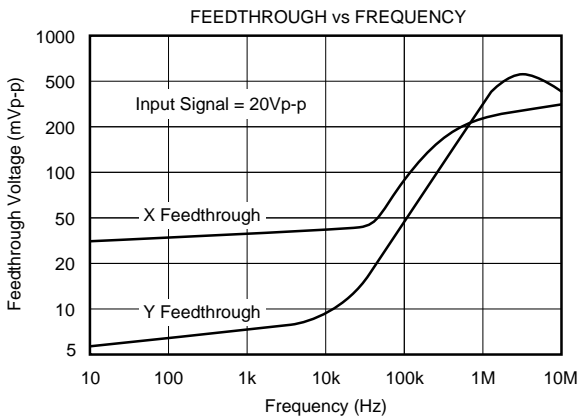
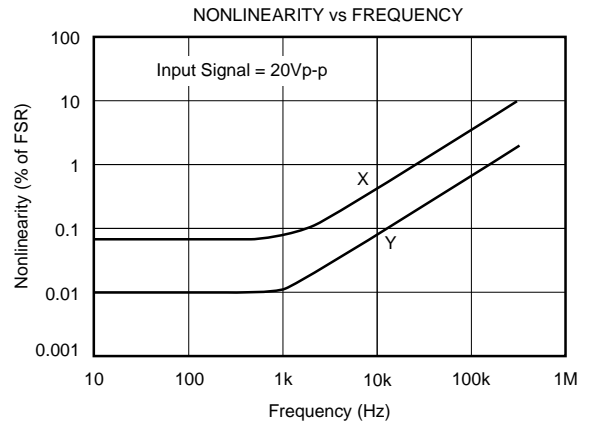
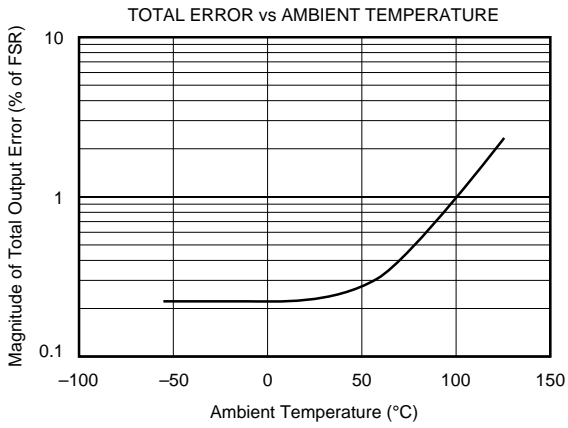
MECHANICAL INFORMATION

| | MILS (0.001") | MILLIMETERS |
|---------------|---------------|-------------------|
| Die Size | 107 x 93 ±5 | 2.72 x 2.36 ±0.13 |
| Die Thickness | 20 ±3 | 0.51 ±0.08 |
| Min. Pad Size | 4 x 4 | 0.10 x 0.10 |
| Backing | | Gold |

MPY100 DIE TOPOGRAPHY

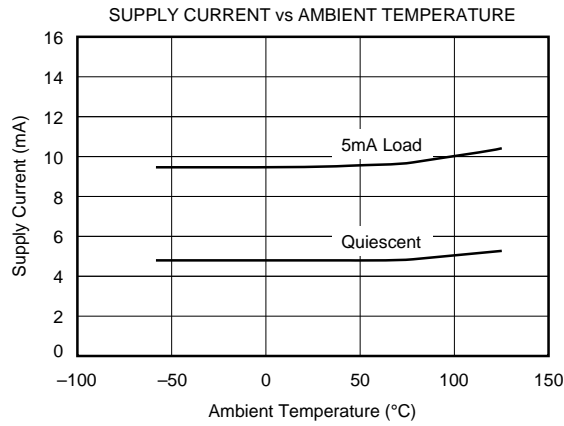
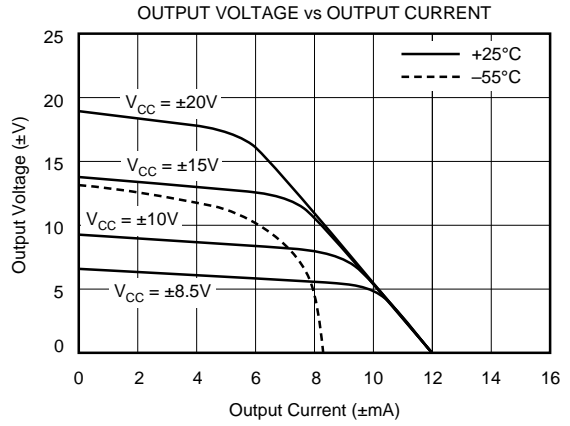
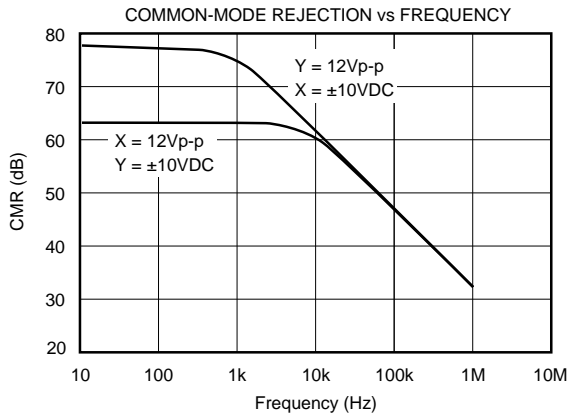
TYPICAL PERFORMANCE CURVES

At $T_A = +25^\circ\text{C}$ and $\pm V_S = 15\text{VDC}$, unless otherwise specified.



TYPICAL PERFORMANCE CURVES (CONT)

At $T_A = +25^\circ\text{C}$ and $\pm V_S = 15\text{VDC}$, unless otherwise specified.



THEORY OF OPERATION

The MPY100 is a variable transconductance multiplier consisting of three differential voltage-to-current converters, a multiplier core and an output differential amplifier as illustrated in Figure 1.

The basic principle of the transconductance multiplier can be demonstrated by the differential stage in Figure 2.

For small values of the input voltage, V_1 , that are much smaller than V_T , the transistor's thermal voltage, the differential output voltage, V_O , is:

$$V_O = g_m R_L V_1$$

The transconductance g_m of the stage is given by:

$$g_m = I_E / V_T$$

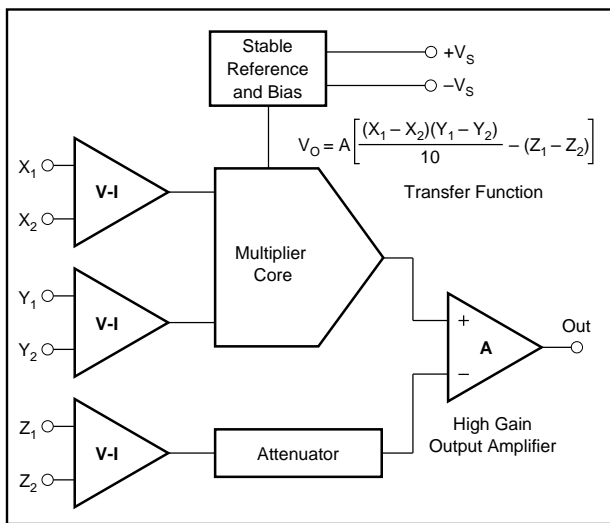


FIGURE 1. MPY100 Functional Block Diagram.

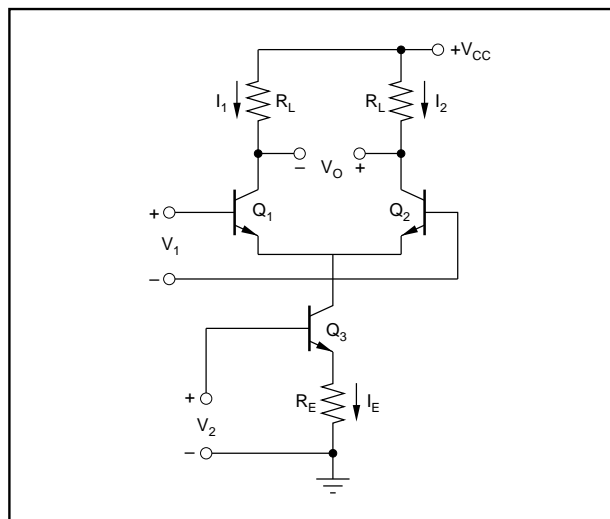


FIGURE 2. Basic Differential Stage as a Transconductance Multiplier.

and is modulated by the voltage, V_2 , to give

$$g_m \approx V_2 / V_T R_E$$

Substituting this into the original equation yields the overall transfer function

$$V_O = g_m R_L V_1 = V_1 V_2 (R_L / V_T R_E)$$

which shows the output voltage to be the product of the two input voltages, V_1 and V_2 .

Variations in I_E due to V_2 cause a large common-mode voltage swing in the circuit. The errors associated with this common-mode voltage can be eliminated by using two differential stages in parallel and cross-coupling their outputs as shown in Figure 3.

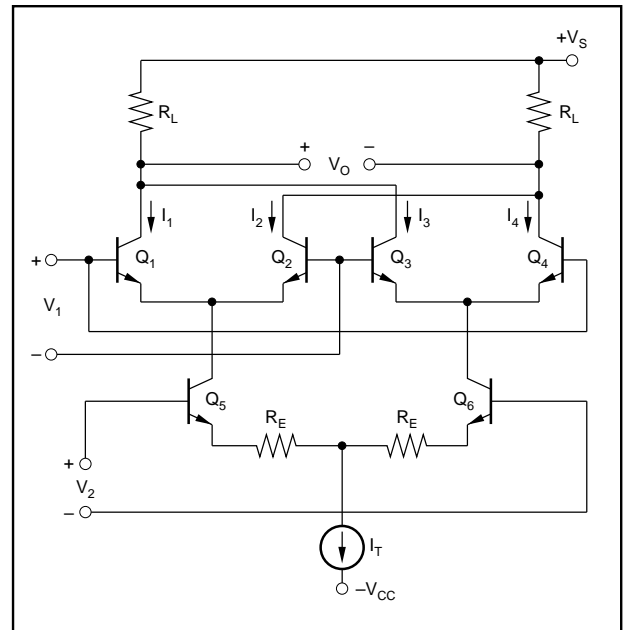


FIGURE 3. Cross-Coupled Differential Stages as a Variable-Transconductance Multiplier.

An analysis of the circuit in Figure 3 shows it to have the same overall transfer function as before:

$$V_O = V_1 V_2 (R_L / V_T R_E)$$

For input voltages larger than V_T , the voltage-to-current transfer characteristics of the differential pair Q_1, Q_2 or Q_3 and Q_4 are no longer linear. Instead, their collector currents are related to the applied voltage V_1

$$\frac{I_1}{I_2} = \frac{I_3}{I_4} = e^{\frac{V_1}{V_T}}$$

The resultant nonlinearity can be overcome by developing V_1 logarithmically to exactly cancel the exponential relationship just derived. This is done by diodes D_1 and D_2 in Figure 4.

The emitter degeneration resistors, R_X and R_Y , in Figure 4, provide a linear conversion of the input voltages to differential current, I_X and I_Y , where:

$$I_X = V_X/R_X \text{ and } I_Y = V_Y/R_Y$$

Analysis of Figure 4 shows the voltage V_A to be:

$$V_A = (2R_L/I_1)(I_X I_Y)$$

Since I_X and I_Y are linearly related to the input voltages V_X and V_Y , V_A may also be written:

$$V_A = KV_X V_Y$$

where K is a scale factor. In the MPY100, K is chosen to be 0.1.

The addition of the Z input alters the voltage V_A to:

$$V_A = KV_X V_Y - V_Z$$

Therefore, the output of the MPY100 is:

$$V_O = A[KV_X V_Y - V_Z]$$

where A is the open-loop gain of the output amplifier. Writing this last equation in terms of the separate inputs to the MPY100 gives

$$V_O = A \left[\frac{(X_1 - X_2)(Y_1 - Y_2)}{10} - (Z_1 - Z_2) \right]$$

the transfer function of the MPY100.

WIRING PRECAUTIONS

In order to prevent frequency instability due to lead inductance of the power supply lines, each power supply should be bypassed. This should be done by connecting a 10 μ F tantalum capacitor in parallel with a 1000pF ceramic capacitor from the + V_{CC} and - V_{CC} pins of the MPY100 to the power supply common. The connection of these capacitors should be as close to the MPY100 as practical.

CAPACITIVE LOADS

Stable operation is maintained with capacitive loads to 1000pF in all modes, except the square root mode for which 50pF is a safe upper limit. Higher capacitive loads can be driven if a 100 Ω resistor is connected in series with the MPY100's output.

DEFINITIONS

TOTAL ERROR (Accuracy)

Total error is the actual departure of the multiplier output voltage from the ideal product of its input voltages. It includes the sum of the effects of input and output DC offsets, gain error and nonlinearity.

OUTPUT OFFSET

Output offset is the output voltage when both inputs V_X and V_Y are 0V.

SCALE FACTOR ERROR

Scale factor error is the difference between the actual scale factor and the ideal scale factor.

NONLINEARITY

Nonlinearity is the maximum deviation from a best straightline (curve fitting on input-output graph) expressed as a percent of peak-to-peak full scale output.

FEEDTHROUGH

Feedthrough is the signal at the output for any value of V_X or V_Y within the rated range, when the other input is zero.

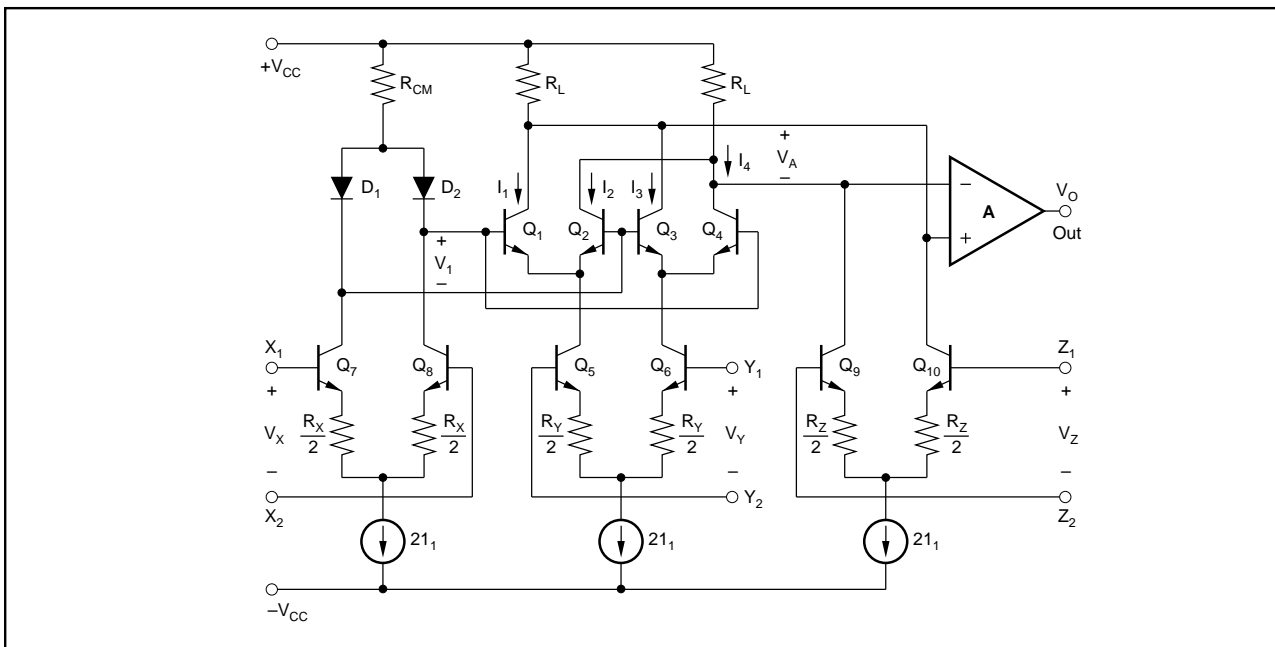


FIGURE 4. MPY100 Simplified Circuit Diagram.

SMALL SIGNAL BANDWIDTH

Small signal bandwidth is the frequency at which the output is down 3dB from its low-frequency value for nominal output amplitude of 10% of full scale.

1% AMPLITUDE ERROR

The 1% amplitude error is the frequency the output amplitude is in error by 1%, measured with an output amplitude of 10% of full scale.

1% VECTOR ERROR

The 1% vector error is the frequency at which a phase error of 0.01 radians (0.57°) occurs. This is the most sensitive measure of dynamic error of a multiplier.

TYPICAL APPLICATIONS

MULTIPLICATION

Figure 5 shows the basic connection for four-quadrant multiplication.

The MPY100 meets all of its specifications without trimming. Accuracy can, however be improved over a limited range by nulling the output offset voltage using the 100Ω optional balance potentiometer shown in Figure 5.

AC feedthrough may be reduced to a minimum by applying an external voltage to the X or Y input as shown in Figure 6.

Z₂, the optional summing input, may be used to sum a voltage into the output of the MPY100. If not used, this terminal, as well as the X and Y input terminals, should be grounded. All inputs should be referenced to power supply common.

Figure 7 shows how to achieve a scale factor larger than the nominal 1/10. In this case, the scale factor is unity which makes the transfer function

$$V_O = KV_X V_Y = K(X_1 - X_2)(Y_1 - Y_2)K = \left[\frac{1 + (R_1/R_2)}{10} \right]$$

$$0.1 \leq K \leq 1$$

This circuit has the disadvantage of increasing the output offset voltage by a factor of 10, which may require the use of the optional balance control as in Figure 1 for some applications. In addition, this connection reduces the small signal bandwidth to about 50kHz.

DIVISION

Figure 8 shows the basic connection for two-quadrant division. This configuration is a multiplier-inverted analog divider, i.e., a multiplier connected in the feedback loop of an operational amplifier. In the case of the MPY100, this operational amplifier is the output amplifier shown in Figure 1.

The divider error with a multiplier-inverted analog divider is approximately:

$$\epsilon_{\text{DIVIDER}} = 10 \epsilon_{\text{MULTIPLIER}} / (X_1 - X_2)$$

It is obvious from this error equation that divider error becomes excessively large for small values of X₁ - X₂. A 10-to-1 denominator range is usually the practical limit. If more accurate division is required over a wide range of denominator voltages, an externally generated voltage may be

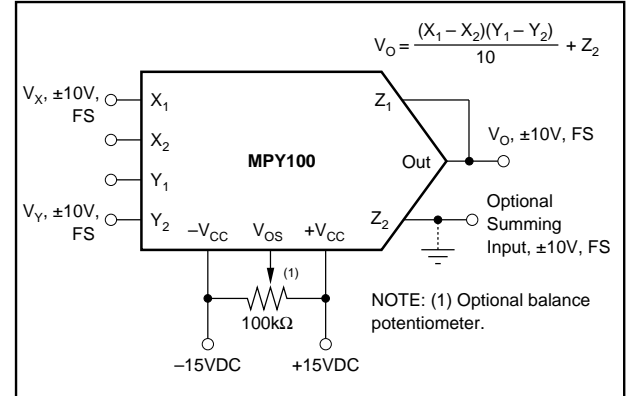


FIGURE 5. Multiplier Connection.

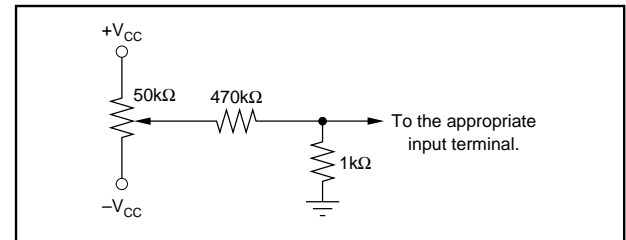


FIGURE 6. Optional Trimming Configuration.

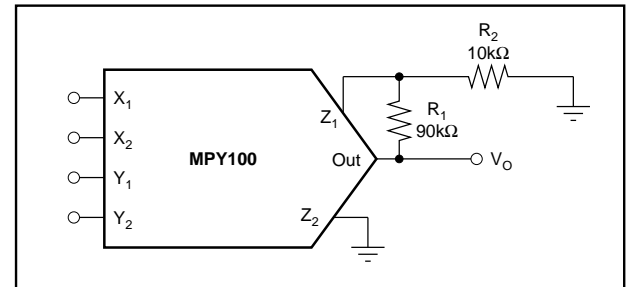


FIGURE 7. Connection for Unity Scale Factor.

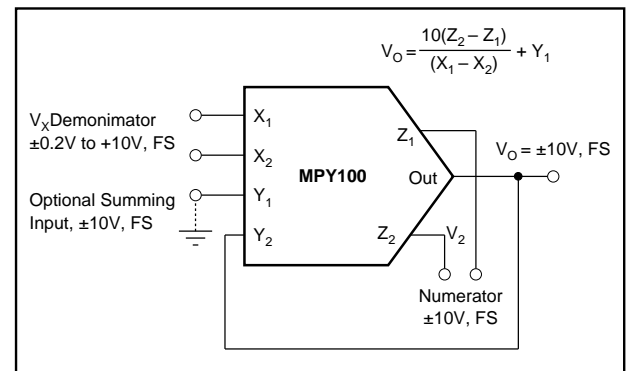


FIGURE 8. Divider Connection.

applied to the unused X-input (see Optional Trim Configuration). To trim, apply a ramp of +100mV to +1V at 100Hz to both X_1 and Z_1 if X_2 is used for offset adjustment, otherwise reverse the signal polarity and adjust the trim voltage to minimize the variation in the output. An alternative to this procedure would be to use the Burr-Brown DIV100, a precision log-antilog divider.

SQUARING

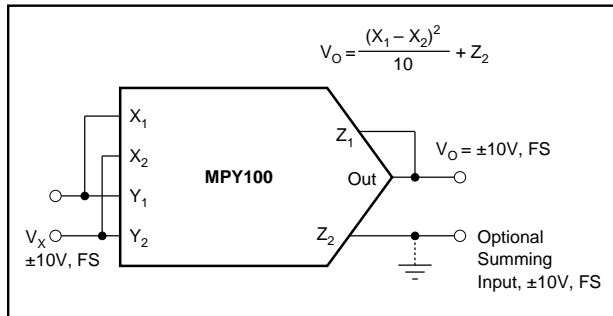


FIGURE 9. Squarer Connection.

SQUARE ROOT

Figure 10 shows the connection for taking the square root of the voltage V_Z . The diode prevents a latching condition which could occur if the input momentarily changed polarity. This latching condition is not a design flaw in the MPY100, but occurs when a multiplier is connected in the feedback loop of an operational amplifier to perform square root functions.

The load resistance, R_L , must be in the range of $10k\Omega \leq R_L \leq 1M\Omega$. This resistance must be in the circuit as it provides the current necessary to operate the diode.

PERCENTAGE COMPUTATION

The circuit of Figure 11 has a sensitivity of 1V/% and is capable of measuring 10% deviations. Wider deviation can be measured by decreasing the ratio of R_2/R_1 .

BRIDGE LINEARIZATION

The use of the MPY100 to linearize the output from a bridge circuit makes the output V_O independent of the bridge supply voltage. See Figure 12.

TRUE RMS-TO-DC CONVERSION

The rms-to-DC conversion circuit of Figure 13 gives greater accuracy and bandwidth but with less dynamic range than most rms-to-DC converters.

SINE FUNCTION GENERATOR

The circuit in Figure 14 uses implicit feedback to implement the following sine function approximation:

$$V_O = (1.5715V_1 - 0.004317V_1^3)/(1 + 0.001398V_1^2) \\ = 10 \sin(9V_1)$$

MORE CIRCUITS

The theory and procedures for developing virtually any function generator or linearization circuit can be found in the Burr-Brown/McGraw Hill book "FUNCTION CIRCUITS - Design and Applications."

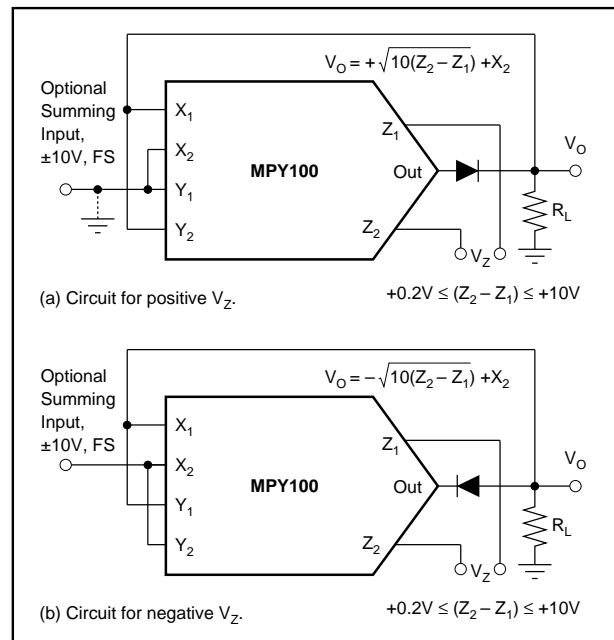


FIGURE 10. Square Root Connection.

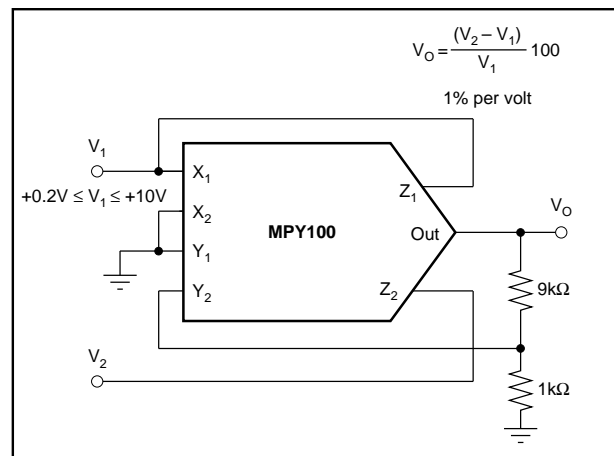


FIGURE 11. Percentage Computation.

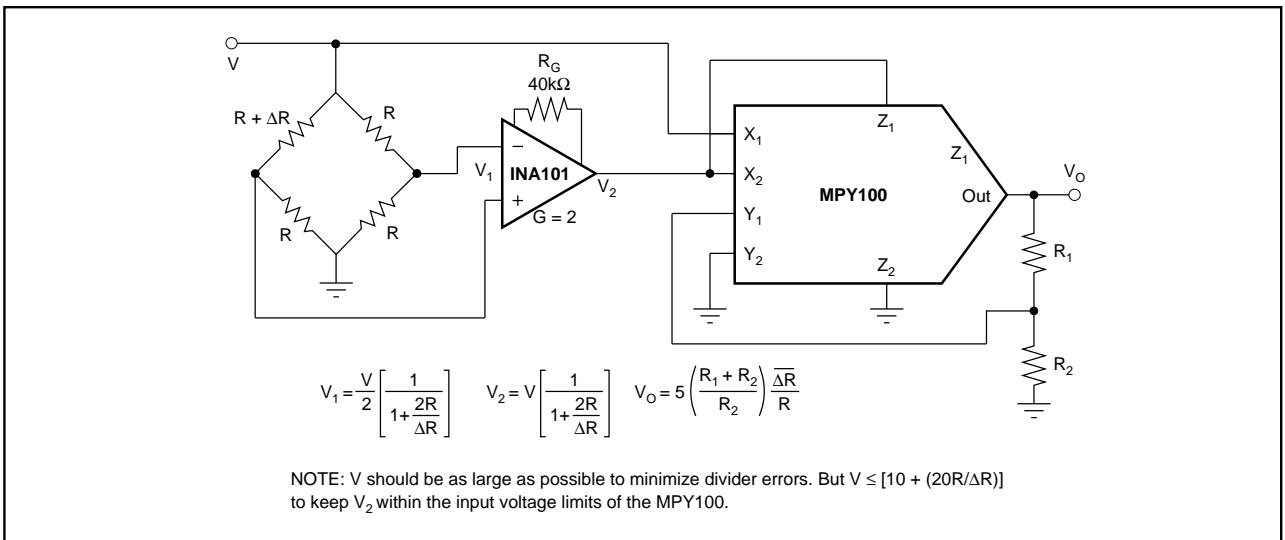


FIGURE 12. Bridge Linearization.

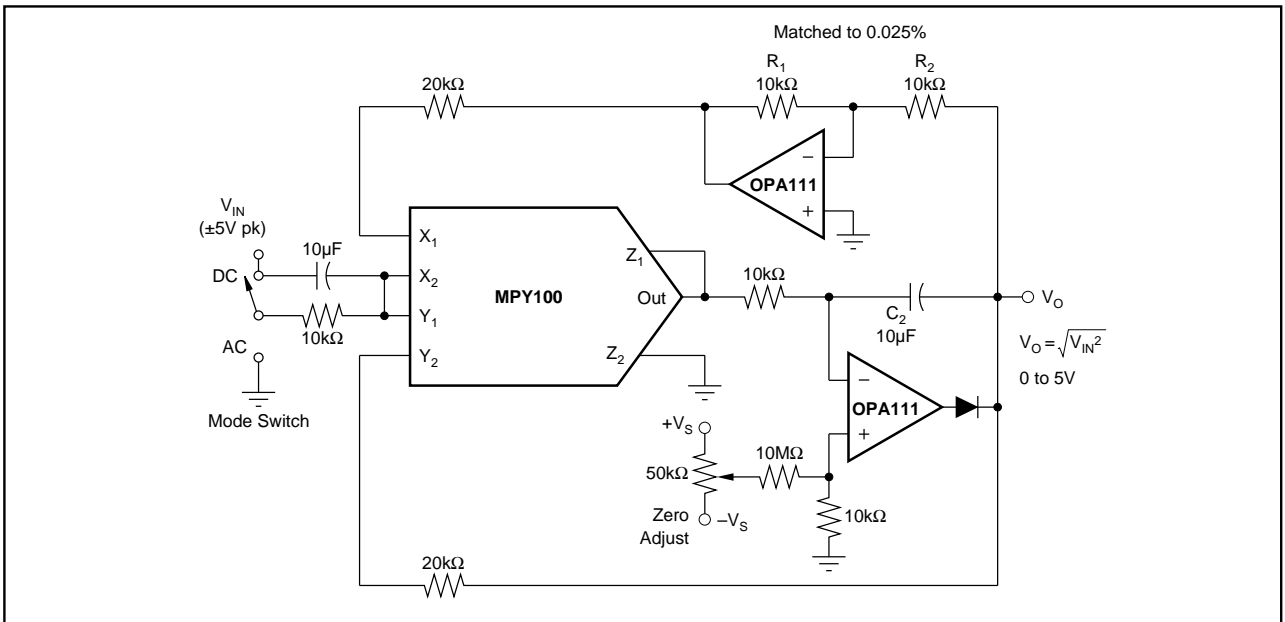


FIGURE 13. True RMS-to-DC Conversion.

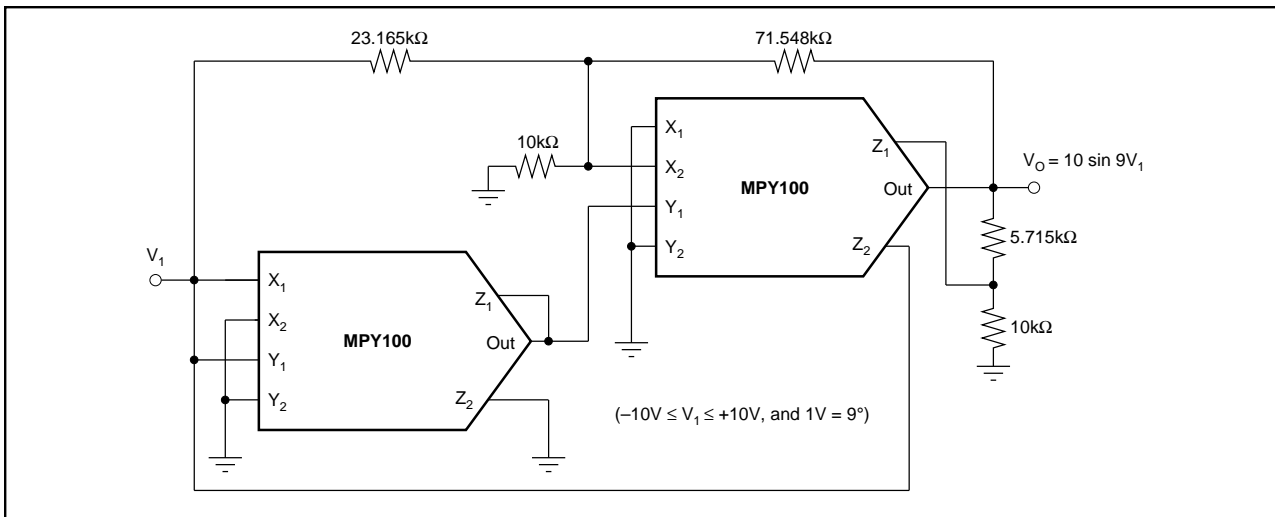


FIGURE 14. Sine Function Generator

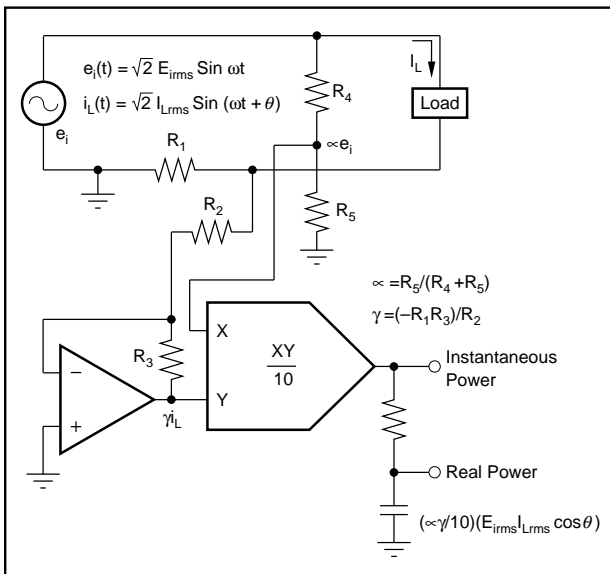


FIGURE 15. Single-Phase Instantaneous and Real Power Measurement.

The information provided herein is believed to be reliable; however, BURR-BROWN assumes no responsibility for inaccuracies or omissions. BURR-BROWN assumes no responsibility for the use of this information, and all use of such information shall be entirely at the user's own risk. Prices and specifications are subject to change without notice. No patent rights or licenses to any of the circuits described herein are implied or granted to any third party. BURR-BROWN does not authorize or warrant any BURR-BROWN product for use in life support devices and/or systems.

PACKAGING INFORMATION

| Orderable Device | Status ⁽¹⁾ | Package Type | Package Drawing | Pins | Package Qty | Eco Plan ⁽²⁾ | Lead/Ball Finish | MSL Peak Temp ⁽³⁾ |
|------------------|-----------------------|--------------|-----------------|------|-------------|-------------------------|------------------|------------------------------|
| MPY100AG | NRND | CDIP SB | JD | 14 | 1 | Green (RoHS & no Sb/Br) | AU | N / A for Pkg Type |
| MPY100AG3 | OBSOLETE | CDIP SB | JD | 14 | | TBD | Call TI | Call TI |
| MPY100AM | OBSOLETE | TO-100 | LME | 10 | | TBD | Call TI | Call TI |
| MPY100BG | NRND | CDIP SB | JD | 14 | 1 | Green (RoHS & no Sb/Br) | AU | N / A for Pkg Type |
| MPY100BG2 | OBSOLETE | CDIP SB | JD | 14 | | TBD | Call TI | Call TI |
| MPY100BM | OBSOLETE | TO-100 | LME | 10 | | TBD | Call TI | Call TI |
| MPY100CG | NRND | CDIP SB | JD | 14 | 1 | Green (RoHS & no Sb/Br) | AU | N / A for Pkg Type |
| MPY100CG1 | OBSOLETE | CDIP SB | JD | 14 | | TBD | Call TI | Call TI |
| MPY100CM | OBSOLETE | TO-100 | LME | 10 | | TBD | Call TI | Call TI |
| MPY100SG | NRND | CDIP SB | JD | 14 | 1 | Green (RoHS & no Sb/Br) | AU | N / A for Pkg Type |
| MPY100SM | OBSOLETE | TO-100 | LME | 10 | | TBD | Call TI | Call TI |

⁽¹⁾ The marketing status values are defined as follows:

ACTIVE: Product device recommended for new designs.

LIFEBUY: TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.

NRND: Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.

PREVIEW: Device has been announced but is not in production. Samples may or may not be available.

OBSOLETE: TI has discontinued the production of the device.

⁽²⁾ Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS), Pb-Free (RoHS Exempt), or Green (RoHS & no Sb/Br) - please check <http://www.ti.com/productcontent> for the latest availability information and additional product content details.

TBD: The Pb-Free/Green conversion plan has not been defined.

Pb-Free (RoHS): TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, TI Pb-Free products are suitable for use in specified lead-free processes.

Pb-Free (RoHS Exempt): This component has a RoHS exemption for either 1) lead-based flip-chip solder bumps used between the die and package, or 2) lead-based die adhesive used between the die and leadframe. The component is otherwise considered Pb-Free (RoHS compatible) as defined above.

Green (RoHS & no Sb/Br): TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

⁽³⁾ MSL, Peak Temp. -- The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

Important Information and Disclaimer: The information provided on this page represents TI's knowledge and belief as of the date that it is provided. TI bases its knowledge and belief on information provided by third parties, and makes no representation or warranty as to the accuracy of such information. Efforts are underway to better integrate information from third parties. TI has taken and continues to take reasonable steps to provide representative and accurate information but may not have conducted destructive testing or chemical analysis on incoming materials and chemicals. TI and TI suppliers consider certain information to be proprietary, and thus CAS numbers and other limited information may not be available for release.

In no event shall TI's liability arising out of such information exceed the total purchase price of the TI part(s) at issue in this document sold by TI to Customer on an annual basis.

IMPORTANT NOTICE

Texas Instruments Incorporated and its subsidiaries (TI) reserve the right to make corrections, modifications, enhancements, improvements, and other changes to its products and services at any time and to discontinue any product or service without notice. Customers should obtain the latest relevant information before placing orders and should verify that such information is current and complete. All products are sold subject to TI's terms and conditions of sale supplied at the time of order acknowledgment.

TI warrants performance of its hardware products to the specifications applicable at the time of sale in accordance with TI's standard warranty. Testing and other quality control techniques are used to the extent TI deems necessary to support this warranty. Except where mandated by government requirements, testing of all parameters of each product is not necessarily performed.

TI assumes no liability for applications assistance or customer product design. Customers are responsible for their products and applications using TI components. To minimize the risks associated with customer products and applications, customers should provide adequate design and operating safeguards.

TI does not warrant or represent that any license, either express or implied, is granted under any TI patent right, copyright, mask work right, or other TI intellectual property right relating to any combination, machine, or process in which TI products or services are used. Information published by TI regarding third-party products or services does not constitute a license from TI to use such products or services or a warranty or endorsement thereof. Use of such information may require a license from a third party under the patents or other intellectual property of the third party, or a license from TI under the patents or other intellectual property of TI.

Reproduction of TI information in TI data books or data sheets is permissible only if reproduction is without alteration and is accompanied by all associated warranties, conditions, limitations, and notices. Reproduction of this information with alteration is an unfair and deceptive business practice. TI is not responsible or liable for such altered documentation. Information of third parties may be subject to additional restrictions.

Resale of TI products or services with statements different from or beyond the parameters stated by TI for that product or service voids all express and any implied warranties for the associated TI product or service and is an unfair and deceptive business practice. TI is not responsible or liable for any such statements.

TI products are not authorized for use in safety-critical applications (such as life support) where a failure of the TI product would reasonably be expected to cause severe personal injury or death, unless officers of the parties have executed an agreement specifically governing such use. Buyers represent that they have all necessary expertise in the safety and regulatory ramifications of their applications, and acknowledge and agree that they are solely responsible for all legal, regulatory and safety-related requirements concerning their products and any use of TI products in such safety-critical applications, notwithstanding any applications-related information or support that may be provided by TI. Further, Buyers must fully indemnify TI and its representatives against any damages arising out of the use of TI products in such safety-critical applications.

TI products are neither designed nor intended for use in military/aerospace applications or environments unless the TI products are specifically designated by TI as military-grade or "enhanced plastic." Only products designated by TI as military-grade meet military specifications. Buyers acknowledge and agree that any such use of TI products which TI has not designated as military-grade is solely at the Buyer's risk, and that they are solely responsible for compliance with all legal and regulatory requirements in connection with such use.

TI products are neither designed nor intended for use in automotive applications or environments unless the specific TI products are designated by TI as compliant with ISO/TS 16949 requirements. Buyers acknowledge and agree that, if they use any non-designated products in automotive applications, TI will not be responsible for any failure to meet such requirements.

Following are URLs where you can obtain information on other Texas Instruments products and application solutions:

Products

| | |
|-----------------------------|--|
| Amplifiers | amplifier.ti.com |
| Data Converters | dataconverter.ti.com |
| DLP® Products | www.dlp.com |
| DSP | dsp.ti.com |
| Clocks and Timers | www.ti.com/clocks |
| Interface | interface.ti.com |
| Logic | logic.ti.com |
| Power Mgmt | power.ti.com |
| Microcontrollers | microcontroller.ti.com |
| RFID | www.ti-rfid.com |
| RF/IF and ZigBee® Solutions | www.ti.com/lprf |

Applications

| | |
|--------------------|--|
| Audio | www.ti.com/audio |
| Automotive | www.ti.com/automotive |
| Broadband | www.ti.com/broadband |
| Digital Control | www.ti.com/digitalcontrol |
| Medical | www.ti.com/medical |
| Military | www.ti.com/military |
| Optical Networking | www.ti.com/opticalnetwork |
| Security | www.ti.com/security |
| Telephony | www.ti.com/telephony |
| Video & Imaging | www.ti.com/video |
| Wireless | www.ti.com/wireless |

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265
Copyright © 2009, Texas Instruments Incorporated

Looking for pricing, stock, or lifecycle information?

Click below to explore more details on WIN SOURCE:

 [View MPY100CG](#) on WIN SOURCE

 [Texas Instruments](#) Information

Optimize Your Supply Chain with WIN SOURCE Solutions

-  Global Sourcing Solution
-  Obsolete Management
-  Cost Control Management
-  Shortage Management
-  Alternative Solution
-  Excess Inventory Management